

# Leisure Time Physical Activity Assessment of American Adults through an Analysis of Time Diaries Collected in 1981

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**Abstract:** One of the 1990 Health Objectives established by the U.S. Department of Health and Human Services is for 60 per cent of adults 18–65 years of age to be participating regularly in vigorous physical exercise. Unfortunately, no valid and practical measurement system is available that will allow assessment of leisure time physical activity participation of large populations. Consequently, not only is it difficult to assess progress toward the 1990 goal, an accurate baseline from which to measure potential progress does not exist. This paper presents a time diary technique for measuring aggregate population physical activity participation and utilizes

actual time diaries collected from adults by the Institute for Social Research in 1981 to arrive at a possible baseline.

The results indicated that time diaries are a viable method for assessing aggregate physical activity behavior of large populations. American Adults were quite sedentary in 1981. Over a period of one week, 31% undertook no leisure time physical activity. Only 14 per cent expended more than 1600 kcals/week in leisure time physical activity, and 10 per cent met the DHHS physical activity requirements. (*Am J Public Health* 1987; 77:455–460.)

## Introduction

A potential link between habitual physical activity and decreased incidence of coronary heart disease<sup>1–3</sup> stimulated the US Department of Health and Human Services to establish the formidable objective of having at least 60 per cent of the adult population 18–65 years of age regularly participating in vigorous physical activity by the year 1990.<sup>4</sup> Unfortunately, there is no valid, reliable, and practical method yet available to track physical activity behavior of large populations<sup>5–8</sup> essentially making it impossible to monitor progress toward the 1990 goal.

Problems with present assessment systems include inadequate measurement of time allocations to physical activity, lack of cost efficient sampling techniques that will account for seasonal variation in terms of “how much”, “what kind”, and “what pattern” of activity,<sup>9</sup> lack of consistency in survey techniques, and unsophisticated analytic strategies.<sup>4</sup> Even the definition of “physical activity” changes from study to study, making it impossible to compare results.<sup>5</sup> Thus, before comparable measures of a diverse behavior such as exercise participation can be obtained there are at least two methodological questions that must be answered:

- What type of instrument will provide the most valid and reliable data on time allocation to physical activities?
- What sampling method will provide reasonable measures of physical activity behavior of a population while also accounting for variation in activity from day to day, week day to weekend, week to week, and season to season?

The present paper examines strategies for solving these questions. It is suggested that aggregate physical activity patterns of the population can be most accurately assessed through the use of four time diaries spread at three-month intervals throughout the year. Actual time diaries collected from a sample of American adults in 1981 utilizing the suggested procedure are then analyzed to calculate a possible baseline measure of adult physical activity participation.

## Methods

### Measuring Duration of Participation

At one end of a scale for measuring how individuals allocate time to daily activities is direct observation. However, many difficulties are encountered with this technique including excessive cost, intrusion into a household's privacy, and questionable accuracy given that individuals tend to change their patterns of behavior when they are being observed.<sup>10</sup> On the other end of the scale is the recall survey where respondents are asked to report upon their frequency of participation and to estimate duration, a format quite common in physical activity assessment studies. After more than 20 years of experience in assessing how Americans allocate time to daily activities, Juster concluded that obtaining data in this manner relies much too heavily upon the respondent's ability to provide accurate information and:

... the best evidence we have suggests that obtaining data on time allocation in the stylized activity mode is not very satisfactory except for sets of activities that are performed with high frequency (preferably daily) and that do not vary greatly in the amounts of time involved.<sup>10</sup>

Adult physical activity behavior violates both these conditions. It is, therefore, necessary to find some reliable measure of actual participation time other than via the “stylized” recall mode.

It is the contention of those who have had experience in assessing how Americans allocate their time that the most accurate cost-efficient method of obtaining data on time use is via diaries that are filled out shortly after the event.<sup>10</sup> Diaries have several advantages over other techniques: they are comprehensive in that all activities are covered; they allow for uniform coding; and time of participation can be more accurately assessed. Diaries also provide an apparent advantage of the non-directed format.<sup>10</sup> Simply asking a respondent “what did you do?” and then allowing an unstructured response does not directly or indirectly suggest desirability. Since numerous investigators<sup>9,11,12</sup> have reported social desirability bias in physical activity assessment studies, any unobtrusive measurement method avoiding this is preferable over those that do not.

The diary method is not without deficiencies, however. A respondent can only recall events that occurred on Mondays through Thursdays if the interview is conducted within 24 hours of the respective days. There is more leeway with Fridays, Saturdays, and Sundays. These days are sufficiently

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distinct that respondents can accurately recall activities and time of participation up to seven days later.<sup>13</sup>

The use of the time diary method is also limited by the frequency of the activities that are of interest. In a sample of two days, for example, there is less than a 45 per cent chance an adult will be found active in sports or exercise over both days.<sup>14</sup> A sample of at least four week days is necessary to obtain an individual active leisure and sport time use reliability of approximately 0.6. Data presently available do not permit any estimates for the number of weekends necessary for a reliable measure. However, a sampling of several Saturdays and Sundays would likely be required to obtain a reasonable estimate of individual participation in leisure time physical activities. Thus the use of time diaries for measuring individual participation, and/or participation of the population in specific forms of physical activities would prove unreasonable both in terms of cost and respondent cooperation.

Utilizing time diaries to measure physical activity participation, therefore, is limited to measuring "aggregate" activity patterns among the adult population at large. Now the problem is one of how to sample respondents and days. According to Juster,<sup>10</sup>

interviewing a representative sample of adults on activities during the previous 24 hours would produce an unbiased estimate of aggregated activity patterns provided the interviews were randomly allocated over all days of the year, thus having the proper expected number of week days, weekend days, vacation days, days with idiosyncratic characteristics.<sup>10</sup>

In reality, however, a completely randomized design is not practical. Only 25 per cent of the interviews can be successfully completed on the first attempt,<sup>14</sup> making it necessary to find some procedure to use when interviews are not completed on the designated date. All possible solutions to this problem add excessively to overall costs of the data collection. One must therefore tackle the sample design issue from a slightly different perspective: how can 24-hour time diaries be made to accurately represent activities for the population as a whole while also avoiding excessive cost?<sup>14</sup>

It turns out that the optimum and most cost-efficient sample design is to collect time diaries from a randomly selected group of individuals on four conveniently selected days throughout the year, including one Saturday, one Sunday, and two week days.<sup>14</sup> A sampling of both weekend days is necessary since these differ both from each other and from week days. Spreading the selected days over the year captures any seasonal variations in time use. Such a technique provides large sampling errors for individuals but are modest for the population as a whole.<sup>14</sup>

#### Estimated Weekly Participation Time

An estimate of average weekly participation time can be derived from the four time diaries collected in the manner just described. A synthetic week can be created by weighting the two week day diaries to adjust for the fact that a week contains five rather than two week days and added to the time use over the Saturday and Sunday diary to estimate time use over seven days.<sup>15</sup> Theoretically, if one were to average time use over all the weeks of the year, one would arrive at that approximated in the synthetic week.

#### Application to a National Assessment

In 1975, the Institute for Social Research at The University of Michigan conducted a national survey on how Americans allocated their time. Four independent time diaries were collected from a sample of American adults at

selected times throughout the year. A follow-up study of the respondents was conducted in 1981. These data are a rich source of information on how Americans allocate time and provide an opportunity to determine if such a procedure is a potentially cost-efficient method for accurately assessing adult physical activity behavior. Data utilized in the present study are from the diaries collected in 1981.<sup>\*\*</sup> The reader is referred to "*Time, Goods and Well-being*,"<sup>15</sup> for a thorough discussion of these data since only those procedures pertinent to the present paper are covered here.

#### Sample Design

Respondents in the 1981 time use study were sampled in 1975-76 and were representative of American adults 18 years of age and older living in the coterminous United States. Four independent estimates of time use were obtained for each respondent, and for a spouse if one was present. The interviews were conducted at approximately three-month intervals so that each quarter of the calendar year was represented. The diary days were conveniently selected so that two were week days, one was a Saturday, and the other a Sunday. The first interview was conducted in person and the remaining three by telephone.

#### Features of the Time Diaries

The diaries were collected by a recall technique with a format developed from several experimental studies in the early 1970s.<sup>13</sup> Basically, it consisted of an open ended question format. The respondent was asked "what were you doing at one minute past midnight on the previous day [diary day]?" followed by "where were you?", "who was with you?", "were you doing anything else at the same time?", and then "what did you do next?" Time was recorded on a continual scale i.e., it was not blocked into 15- or 30-minute intervals. The interview continued in this manner until activities over 24 consecutive hours had been recorded. All diary activities were later coded into 200 mutually exclusive categories along with actual time duration. In all, 26 active leisure time activities had been identified and coded. These were extracted from the diaries along with participation time for analysis in the present study.

#### Synthetic Week Estimate

Using the method already discussed, a synthetic week of leisure time physical activity participation was formed from the four time diaries. Participation time in the two week day diaries was weighted by a factor of 2.5 so that an aggregate time over five week days could be estimated. This aggregate week day time was added to that recorded in the Saturday and Sunday diaries so that the amount of physical activity undertaken in one full week could be estimated.

The pattern of days and season making up the synthetic week were as follows: wave 1 (February-April) consisted predominantly of week days; wave 2 (May-July) was a mixture of all seven days with Sunday being the most heavily sampled day; wave 3 (August-September) consisted of Saturday and Sunday diaries; and wave 4 (November-December) week days. Thus, over the warmer months, there is a good representation of both Saturdays and Sundays capturing the seasonal variability in weekend activities. The reader

<sup>\*\*</sup>These data were made available by the Inter-university Consortium for Political and Social Research. The data for Time Use in Economic and Social Accounts, 1981 were originally collected by F. Thomas Juster, Paul Courant, Greg J. Duncan, John P. Robinson, and Frank Stafford. Neither the original collectors of the data nor the Consortium bear any responsibility for the analysis or interpretations presented here.

is reminded that this synthetic week is not intended to represent the amount of physical activity undertaken by the specific individual. It simply allows one to estimate aggregate activity patterns of the adult population at large.

#### Data Limitations

It is important to understand limitations of the 1981 time diary data set. The study was a follow-up of households that had participated in 1975–76, and there was no contact in the intervening five or six years. Consequently, only a limited number of households could be contacted in the follow-up. The sample size is extremely small with 620 respondents and 376 spouses entering the first wave in 1981 and 493 respondents and 241 spouses remaining after four waves.

Such large drop-out rates cannot be ignored. Specific types of individuals are more likely to drop out of a survey than others adversely affecting the results even when one begins with a random sample. Some procedure is therefore necessary to retain the representativeness of the initial sample. One technique is to increase the impact the remaining respondents have upon the results according to the demographics of those who have dropped out. In commenting about the drop-out rate of respondents in the time diary study, Juster made the following observation:

While all survey data are subject to non-response, it should be kept in mind that we know a good bit about the nature and character of non-response over the entire period (except for the original non-response in the first wave of the 1975 survey). We have data on the financial and demographic characteristics of our original respondents, and can reweight those who completed the 1981–82 follow-up to account for the differential non-response associated with these characteristics.<sup>16</sup>

The original investigators calculated a weight for each respondent that increased or decreased their influence upon the aggregate according to sex, age, education, and degree of urbanization in which the selected household was located. Such a correction adjusts for both the type of activity and the participation time so that those respondents remaining more accurately represent the population at large. Thus, while it was not possible to cure the deficiency relating to the absence of a cohort that would have been age 18 through 24 in 1981, it was possible to correct for respondent dropout. However, despite these corrections one still cannot consider these data to be an ideal representative cross-section of the American adult population. Caution is therefore necessary in interpretation of the results.

One further limitation relating to coding procedures must be noted. While the coded activity categories were well suited for the purposes of the original investigators, in some cases they are not quite specific enough for an analysis of physical activity behavior. Categories such as “team sports” and “racquet sports” cover a wide range of activities with varying degrees of intensity. In addition, the original investigators did not probe respondents for information on whether the time specified was actual participation time or whether it included other time as well. There is no way of knowing what portion of the time allocated to racquet sports, for instance, was actual playing time, and what part was social, resting, or dressing time. Upon investigating secondary activities undertaken while respondents were participating in the primary activity, discrepancies became apparent. The activity of swimming, for example, merely indicated respondents were somewhere near water. According to their secondary activities, many respondents were also listening to the radio, reading, or napping when they recorded swimming as

their primary activity. Similarly, secondary activities during team sport and racquet sport participation indicated respondents did not spend the total time indicated in their diaries actually playing. In essence, the leisure time participation data from this set of time diaries are inflated to some degree.

#### Classifying Diary Participation Time into an Activity Index

The amount of energy expended and intensity of the activity have both been identified as factors in cardiovascular disease prevention. There is evidence, for example, that a weekly physical activity energy expenditure of 2000 kcal is associated with decreased incidence of cardiovascular disease.<sup>1</sup> Other evidence suggests that regular moderate activities may be sufficient to protect against cardiovascular disease and aid in weight control.<sup>9</sup> It appears, however, that one must undertake fairly vigorous forms of physical activity to produce cardiovascular and metabolic benefits.<sup>4,17,18</sup> Some means of characterizing activity intensity along with duration is required so that it becomes possible to understand the relation between physical activity behavior and health.

A method of accomplishing this is to form an activity index that is based upon the intensity of the activity and time of participation. Prior to undertaking any analyses, activities are classified according to whether they are light, moderate, or heavy.<sup>9,19</sup> An index of energy expenditure is then calculated and total physical activity is then expressed in terms of per cent low, moderate, and heavy intensity.

Taylor, *et al.*,<sup>19</sup> have validated an Activity Metabolic Index for converting participation time in leisure time physical activity into an approximate kcal/min of energy expenditure. The basic formula is:

$$AMI = I \cdot D$$

where: AMI = Activity Metabolic Index

I = intensity code

D = duration of the activity in minutes per year.

One intensity unit roughly equals 1 kcal/min and is partly based on  $V_{O_2}$  experimentation and partly upon practical experience with middle-aged, middle-class American men.<sup>19</sup> Activity intensity codes have been made available for a variety of leisure time physical activities.<sup>19–21</sup>

The activities undertaken by the 1981 time diary sample and their intensity codes are listed in Table 1. The light activity category in the present study included those activities with intensity codes of 3.5 or less. Moderate activities included those with intensity codes of 4.0–4.5 and those 5.0 and above were classified as heavy (Table 1). Swimming was adjusted from the intensity code of 6 proposed by Taylor, *et al.*,<sup>19</sup> to a code of 4 to help correct for the inflation bias previously mentioned. This was the most seriously affected activity and thus was the only intensity code adjusted.

Following the procedure outlined by Taylor, *et al.*,<sup>19</sup> all active leisure activities reported in the 1981 time diaries was classified as light, moderate, or heavy. An intensity index was then calculated for each category of activity where:

Activity Index (AI) = time of participation in minutes over the synthetic week  $\times$  intensity code

Thus:

$$AI_{\text{total}} = AI_{\text{light}} + AI_{\text{moderate}} + AI_{\text{heavy}}$$

Where:

$$AI_{\text{light}} = \text{activity index for all light activities}$$

**TABLE 1—Intensity Codes of American Adult Leisure Time Physical Activities Reported in 1981 Time Diaries**

Activity	Intensity Code
(a) Light Intensity Activities	
Bowling	3.0
Fishing	3.5
Boating/sailing	3.0
Horseback riding	3.5
Gardening indoors	3.0
Pet care	3.5
Other active leisure (includes: swinging in park, feeding birds, etc)	3.5
(b) Moderate Intensity Activities	
Golfing	4.0
Frisbee/catch	4.5
Exercises/yoga	4.5
Hunting	4.0
Walking	4.0
Hiking	4.5
Bicycling	4.0
Swimming	4.0
Carpentry	4.0
Gardening outdoors	4.5
Grounds improvement	4.0
Social dancing	4.0
(c) Heavy Intensity Activities	
Team sports	6.0
Racket sports	6.0
Skating/skiing	7.0
Jogging	7.0
Lessons: body movements	6.0
Dance: body movements	6.0

$AI_{\text{moderate}}$  = activity index for all moderate activities

$AI_{\text{heavy}}$  = activity index for all heavy activities

### Analysis

All analyses were conducted using the OSIRIS statistical package<sup>22</sup> and the computing facilities at The University of Michigan. \*\*\*

For the purposes of this study, only leisure time physical activity involving some measure of bodily movement is analyzed. While it was easy to categorize most activities into an active-passive dimension based on this definition, camping and picnicking presented a problem. There was no way of determining how much actual "bodily" movement took place during these time periods and since they were likely to be more "passive" than "active" they were not included in the analysis. The activities included are listed in Table 1.

### Results

#### Respondent Characteristics

All results presented here have been weighted according to weights provided by the original investigators to correct for respondent dropout. Mean age was 42.2 years (standard deviation (SD) = 11.2). Fifty one per cent of the weighted sample were men and 49 per cent were women. Age ranged from 25–65 years and 83 per cent were married. Further respondent characteristics can be found in Table 2.

#### Activity Index

The mean leisure time physical activity index for this sample of American adults (including non-actives) in 1981 was 677 kcals per week. Of that total, 35 per cent consisted of  $AI_{\text{light}}$ , 48 per cent  $AI_{\text{moderate}}$ , and 17 per cent  $AI_{\text{heavy}}$ . Men

**TABLE 2—Characteristics of Respondents Participating in the 1981 Time Diary Study**

Respondent Characteristics	Per Cent* (N = 628)
Education	
Did not graduate HS	18.0
HS graduate	40.6
Some college	20.7
College graduate	14.0
Advanced college degree	6.7
Work Status	
Work full-time	73.6
Work part-time	4.3
Unemployed	2.3
Retired/disabled	5.3
Student	0.6
Keep house	13.7
Marital Status	
Married	83.2
Separated	0.5
Divorced	9.5
Widowed	3.6
Never married	2.2
N.A.	1.1
Age Distribution (years)	
25–34	30.5
35–44	30.0
45–54	21.0
55–65	18.4

\*These percentages have been weighted to correct for respondent dropout over the course of the study. Corrections are based on age, education, sex, and degree of urbanization in which respondent household was located.

had a higher activity index than women and, although the percentage consisting of light activity were similar for both sexes, women had a higher percentage in the moderate range and a lower percentage in the heavy range (Table 3).

#### Activity Participation Status

The sample was divided into non-actives, low-actives, medium-actives and high-actives. Non-actives recorded no physical activity participation time over the synthetic week. Low-actives were those who participated only in the light intensity activities. Medium-actives participated in at least one of the moderate intensity activities and high-actives participated in at least one of the heavy intensity activities. It turns out, not unexpectedly, that medium-actives also undertook some light intensity activities. Their total intensity index consists of 76 per cent  $AI_{\text{moderate}}$  and 24 per cent  $AI_{\text{light}}$ . The high-actives also participated in both moderate and low intensity activities. Their total intensity index consists of 12 per cent  $AI_{\text{light}}$ , 28 per cent  $AI_{\text{moderate}}$ , and 60 per cent  $AI_{\text{heavy}}$ . Men and women were similar except that women had a slightly lower  $AI_{\text{heavy}}:AI_{\text{total}}$  ratio (58 per cent) than men (62 per cent), and a slightly higher  $AI_{\text{moderate}}:AI_{\text{total}}$  ratio than men (31 vs 28 per cent).

Of the total sample, 31 per cent (29 per cent of the men and 33 per cent of the women) engaged in no leisure time physical activity over the synthetic week. The break down among the intensity categories was as follows: 23 per cent of both sexes participated only in light activities, 36 per cent of both sexes participated in a combination of medium and light activities but no heavy intensity activities, and 10 per cent (13 per cent of the men and 7 per cent of the women) participated in any of the heavy intensity activities.

The range of the intensity index varied widely for low-, medium-, and high-actives (Figure 1). To place this distribu-

\*\*\*Computer funds for the analysis of these data were made available through The University of Michigan Computing Center Faculty Request Account.

TABLE 3—Mean Weekly Leisure Time Physical Activity Energy Expenditure of American Adults 25–65 Years of Age in 1981

	Total Population (n = 628) WTN = 159585			Men (n = 290) WTN = 81428			Women (n = 338) WTN = 78157		
	Mean AI†	SD‡	% Distr**	Mean AI	SD	% Distr	Mean AI	SD	% Distr
AI <sub>total</sub>	677	1086		754	1139		597	1024	
AI <sub>light</sub>	240	491	35%	268	516	36%	211	464	35%
AI <sub>moderate</sub>	323	733	48%	336	678	45%	310	787	52%
AI <sub>heavy</sub>	113	521	17%	150	657	19%	76	323	13%
Age (years)	42.2	11.2		42.3	10.9		42.2	11.5	

\*Data have been weighted to correct for respondent dropout.

†Mean AI = Mean leisure time physical activity index (Kcals) for 1 week

‡S.D. = Standard deviation

\*\*% Distribution = percent of AI<sub>total</sub> consisting of light, moderate, and heavy intensity activity.

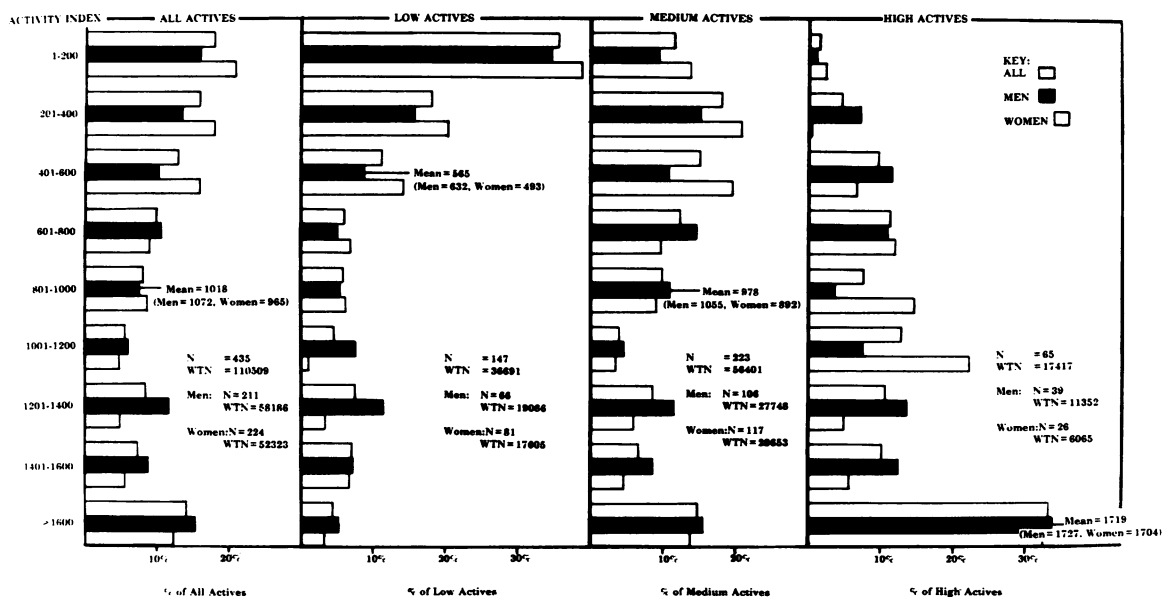


FIGURE 1—Distribution of Leisure Time Physical Activity according to a Derived Activity Index for American Adults in 1981.

tion into an understandable perspective, one can first analyze the AI<sub>total</sub> distribution. According to Paffenbarger, *et al*,<sup>1</sup> 2000 kcal or more of exercise energy expenditure per week is associated with lower incidence of coronary disease. Paffenbarger, *et al*, expanded physical activity into the work hours by asking respondents to estimate on the job activities such as flights of steps walked and other walking distance in terms of city blocks. These activities were not analyzed in the present study. The results obtained by Paffenbarger, *et al*, were also based upon data collected by a recall survey mode. It was therefore felt that the threshold level of actual leisure time physical activity was closer to 1600 kcal/week, once adjustments were made for both these factors in the Paffenbarger study.<sup>1</sup>

Only 14 per cent of the time diary sample (15 per cent of the men and 12 per cent of the women) expended more than 1600 kcals/week. Just 4.4 per cent of the low actives (5 per cent of the men and 3 per cent of the women) and approximately 14 per cent of medium actives (15 per cent of the men and 14 per cent of the women) were above 1600 kcals/week of leisure time physical activity.

A second approach is to analyze the distribution according to the goals established by the US Department of Health

and Human Services.<sup>4</sup> The minimum goal for the population is 20 minutes of heavy activity three days/week. The desired intensity index is, therefore, between 360 and 420 kcals/week (20 min × 3 days × 6 or 7 intensity code) of heavy activity. In this instance, 10 per cent of the population (13 per cent of the men and 7 per cent of the women) met the requirements.

Yet a third approach is to utilize a combination of the Paffenbarger,<sup>1</sup> and the DHHS<sup>4</sup> definitions of energy expenditure requirements. Thus, if non-actives are excluded along with all low-actives and medium-actives not meeting the 1600 kcal/week energy expenditure, and high-actives not meeting the DHHS desired AI intensity, approximately 16 per cent of the population (19 per cent of the men and 13 per cent of the women) met threshold levels of activity thought to prevent cardiovascular disease.

One further feature about the distribution in Figure 1 warranting discussion is the usual evidence that women are less active than men. However, whereas low-active women have an AI<sub>total</sub> that is 78 per cent of the male AI<sub>total</sub>, the AI<sub>total</sub> for medium-active women moves to 85 per cent that of the male medium-actives and the AI<sub>total</sub> for high-active women is 99 per cent that of the male high-actives. Apparently non-active and low-active women have the largest detrimental

effect on the overall activity status of women when they are compared with men.

### Discussion and Conclusions

To the authors knowledge, this is the first attempt at calculating a national measure of American adult physical activity behavior through an analysis of time diaries. Unfortunately, there is no way to confirm the results. Other investigators<sup>19</sup> have reported an average daily physical activity index of 1680 kcals/week for a regional adult population. It is unclear what activities these authors included in their analysis or whether it was based on the total population sample or solely upon those reporting some physical activity. However, allowing for inflation due to the stylized recall survey mode used by these investigators and assuming their calculations were based upon individuals reporting physical activity participation, their results are in reasonable agreement with the 1018 kcals/week of average weekly leisure time physical activity energy expenditure of active individuals found in the present study.

Another study,<sup>21</sup> again regional in coverage, found that 34 per cent of the men and 17 per cent of the women ages 25–74 years achieved 2000 kcal or more per week. This is higher than the 15 per cent and 12 per cent found in the present study. However, Folsom, *et al*,<sup>21</sup> utilized a stylized recall survey. Respondents were asked to report on their participation, the specific months they participated, the average number of occasions they participated in each month, and the average duration on each occasion. Given the inherent problems with this technique, the results obtained from the time diaries are likely to be a better approximation of the actual physical activity energy expenditure of American adults.

That is not to say, however, that the set of time diaries used to generate the results in the present study was as accurate as they potentially could have been. While it was possible to utilize weighting procedures to correct for respondent dropout over the course of the study, little could be done to correct for participation time inflation bias. Better probing techniques, such as those used by Taylor, *et al*,<sup>19</sup> and Sallis, *et al*,<sup>9</sup> will be necessary if the techniques described here are utilized in future assessment of aggregate population physical activity behavior.

The results of the present study suggest that American adults 25–65 years of age were quite sedentary in 1981 with only 10–17 per cent meeting thresholds of physical activity thought to prevent cardiovascular disease. Theoretically, trends in the physical activity status of American adults in this age range should be possible if a similar sample is drawn in 1990. This is more than has been possible to date.

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